Low-frequency Acoustic Measurements in Xenon Near the Critical Point

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In preparation for a microgravity experiment to measure the bulk viscosity of xenon near its critical point, we measured the dispersion and the attenuation of sound in xenon at its critical density in Earth's gravity. We shall compare our results with current theories [1]. The present measurements were obtained using several non-degenerate modes of a novel acoustic resonator operating at comparatively low frequencies ranging from 100 Hz to 5 kHz. We validated our techniques by using the same resonator to measure the speed of sound and the attenuation of sound in argon, methane, and xenon at lower densities. The planned microgravity experiment will measure the asymptotic behavior of the bulk viscosity near the liquid-vapor critical point of xenon, 60 times closer to the critical temperature Tc than any previous measurements [2,3]. To determine the bulk viscosity, we will measure the acoustic dispersion and attenuation in a specially designed acoustic resonator at frequencies down to ~100 Hz, 4000 times lower than those used heretofore. These lower frequencies will probe the bulk viscosity in the very-near-critical region where the corrections to asymptotic behavior are small and, thereby, will provide a tool to test the theory of bulk viscosity as it relates to critical phenomena. The accuracy of these new measurements will be sufficient to eliminate the uncertainties currently associated with the analysis of previous 1-g experiments [4].

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